NEPOOL PLANNING PROCEDURE NO. 3

RELIABILITY STANDARDS FOR THE NEW ENGLAND POWER POOL

RECOMMENDED FOR
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RELIABILITY STANDARDS FOR THE NEW ENGLAND POWER POOL

1. INTRODUCTION

The New England Power Pool (NEPOOL) Agreement provides for the establishment of reliability standards for the bulk power supply of NEPOOL. The reliability standards set forth herein have been adopted as appropriate for the NEPOOL **bulk power supply system**[1]**.** Further, they are consistent with those established by the Northeast Power Coordinating Council in the NPCC "Basic Criteria for Design and Operation of Interconnected Power Systems" and the "Bulk Power System Protection Criteria."

The purpose of these NEPOOL Reliability Standards is to assure the reliability and efficiency of the New England interconnected **bulk power supply system** through coordination of system planning, design and operation. These standards apply to all entities comprising or using the New England interconnected **bulk power supply system**. The host Participant (the Participant through which a non-member connects to the **bulk power supply system**) shall use its best efforts to assure that, whenever it enters into arrangements with non-participants, such arrangements are consistent with these standards.

These Reliability Standards establish minimum design criteria for the New England interconnected **bulk power supply system**. It is recognized that more rigid design and operating criteria may be applied in some segments of the pool because of local considerations. Any constraints imposed by the more rigid criteria will be taken into account in all testing. It is also recognized that the Reliability Standards are not necessarily applicable to those **elements** that are not a part of the New England interconnected **bulk power supply system**.

Because of the long lead times required for the planning and construction of generation and transmission facilities versus the short lead times available for responding to changed operating conditions, it is necessary that criteria for planning and design vary in some respects from the Operating Procedures and Market Rules and Procedures used in actual operations. The intent is to have the system operate at the level of reliability that was contemplated at the time it was designed. For this reason, it is necessary that the design criteria simulate the effects of the equipment outages which may be expected to occur in actual operation. Nevertheless, it should be recognized that in actual operations, it may not always be possible to achieve the design level of reliability due to delays in construction of critical facilities, excessive forced outages, or loads exceeding the predicted levels.

[1] Terms in bold typeface are defined in Appendix A.

These Reliability Standards are intended to be used for planning and design of the New England interconnected bulk power system. Reliability criteria and procedures for operations are detailed elsewhere, with the primary reliability-related documents used in system dispatch and operations being:

1. NEPOOL Operating Procedure No. 1 – Central Dispatch Operating Responsibility and Authority of ISO New England, the Satellites and Participants
2. NEPOOL Operating Procedure No. 3 – Transmission Maintenance Scheduling for Facilities Operating at 115KV and Above
3. NEPOOL Operating Procedure No. 4 - Action During a Capacity Deficiency
4. NEPOOL Operating Procedure No. 5 – Generation Maintenance and Outage Scheduling
5. NEPOOL Operating Procedure No. 6 – System Restoration
6. NEPOOL Operating Procedure No. 7 - Action in an Emergency
7. NEPOOL Operating Procedure No. 8 - Operating Reserve and Automatic Generation Control
8. NEPOOL Operating Procedure No. 11 – Black Start Capability Testing
9. NEPOOL Operating Procedure No. 12 - Voltage and Reactive Control
10. NEPOOL Operating Procedure No. 13 - Standards for Voltage Reduction and Load Shedding Capability
11. NEPOOL Operating Procedure No. 14 – Technical Requirements for Generation, Dispatchable Loads and Interruptible Loads
12. NEPOOL Operating Procedure No. 17 – Load Power Factor Correction
13. NEPOOL Operating Procedure No. 18 – Metering and Telemetering Criteria
14. NEPOOL Operating Procedure No. 19 - Transmission Operations

The interconnected **bulk power supply system** shall be designed for a level of reliability such that the loss of a major portion of the system, or unintentional separation of any portion of the system, will not result from reasonably foreseeable **contingencies**. Therefore, the system is required to be designed to meet representative **contingencies** as defined in these Reliability Standards. Analyses of simulations of these **contingencies** should include assessment of the potential for widespread cascading outages due to overloads, instability or voltage collapse. The loss of small portions of the system may be tolerated provided the reliability of the overall interconnected system is not jeopardized.

The standards outlined hereinafter are not tailored to fit any one system or combination of systems but rather outline a set of guidelines for system design which will result in the achievement of the desired level of reliability and efficiency for the New England interconnected **bulk power supply system**.

2. RESOURCE ADEQUACY

Resources will be planned and installed in such a manner that, after due allowance for the factors enumerated below, the probability of disconnecting noninterruptible customers due to **resource** deficiency, on the average, will be no more than once in ten years.

a. The possibility that load forecasts may be exceeded as a result of weather variations.

b. Immature and mature **equivalent forced outage rates** appropriate for generating units of various sizes and types, recognizing partial and full outages.

c. Seasonal adjustment of **resource** capability.

d. Proper maintenance requirements.

e. Available operating procedures.

f. The reliability benefits of interconnections with systems that are not NEPOOL Participants.

g. Such other factors as may from time-to-time be appropriate.

For planning purposes, the assumed **equivalent forced outage rate** of a generating unit connected to the transmission network by a radial transmission line will be increased to reflect the estimated transmission line forced outage rate if significant.

The potential power transfers from outside New England that are considered in determining the New England capacity requirements must not exceed the **emergency** inter-Area transmission transfer capabilities, as determined in accordance with Section 4.2, using long term emergency (LTE) ratings.

3. AREA TRANSMISSION REQUIREMENTS

The New England interconnected **bulk power supply system** shall be designed with sufficient transmission capacity to integrate all **resources** and serve **area** loads under the conditions noted in Sections 3.1 and 3.2. These requirements will also apply after any critical generator, transmission circuit, transformer, phase angle regulating transformer, HVDC pole, series or shunt compensating device has already been lost, assuming that the **area resources** and power flows are adjusted between outages, using all appropriate reserve **resources** available in ten minutes and where applicable, any phase angle regulator control, and HVDC control.

With due allowance for generator maintenance and forced outages, design studies will assume power flow conditions with applicable transfers, load, and **resource** conditions that reasonably stress the system. Transfers of power to and from another **Area**, as well as within New England, shall be considered in the design of inter-Area and intra-Area transmission facilities.

Transmission transfer capabilities will be based on the load and **resource** conditions expected to exist for the period under study and shall be determined in accordance with Section 4.1 for normal transfers, and Section 4.2 for **emergency** transfers. All reclosing facilities will be assumed in service unless it is known that such facilities have been or will be rendered inoperative.

In applying these criteria, it is recognized that it may be necessary to restrict the output of a generating station(s) and/or HVDC terminal(s) following the loss of a system **element**. This may be necessary to maintain system stability or to maintain line loadings within appropriate thermal ratings in the event of a subsequent outage. But, the system design must be such that, with all transmission facilities in service, all **resources** required for reliable and efficient system operation can be dispatched without unacceptable restriction.

Special protection systems (SPSs) may be employed in the design of the interconnected power system. The requirements for the design of SPSs are defined in the NPCC "Bulk Power System Protection Criteria" and the NPCC "Special Protection System Guideline". A set of guidelines for application of SPSs on the NEPOOL system are contained in the “NEPOOL Special Protection Systems Application Guidelines”. All SPSs proposed for use on the NEPOOL system must be reviewed and approved by NEPOOL, the System Operator and NPCC.

3.1 STABILITY ASSESSMENT

The New England **bulk power supply system** shall remain stable during and following the most severe of the **contingencies** stated below **with due regard to reclosing**, and before making any manual system adjustments.

a. A permanent three-phase fault on any generator, transmission circuit, transformer, or bus section with **normal fault clearing**.

b. Simultaneous permanent phase-to-ground faults on different phases of each of two adjacent transmission circuits on a multiple circuit transmission tower, with **normal fault clearing**. If multiple circuit towers are used only for station entrance and exit purposes, and if they do not exceed five towers at each station, then this condition and other similar situations can be excluded on the basis of acceptable risk, provided that NEPOOL specifically approves each request for exclusion. Similar approval must be granted by the NPCC Reliability Coordinating Committee.

c. A permanent phase-to-ground fault on any transmission circuit, transformer or bus section with **delayed fault clearing**. This **delayed fault clearing** could be due to circuit breaker, relay system or signal channel malfunction.

d. Loss of any **element** without a fault.

e. A permanent phase-to-ground fault in a circuit breaker, with **normal fault clearing**. (**Normal fault clearing** time for this condition may not be high speed.)

f. Simultaneous permanent loss of both poles of a **direct current bipolar** facility without an ac fault.

g. The failure of any SPS which is not functionally redundant to operate properly when required following the **contingencies** listed in "a" through "f" above.

h. The failure of a circuit breaker associated with an SPS to operate when required following: loss of any **element** without a fault; or a permanent phase to ground fault, with **normal fault clearing**, on any transmission circuit, transformer, or bus section.

3.2 STEADY STATE ASSESSMENT

a. Reactive power capacity with adequate reserves and appropriate controls shall be installed to maintain voltages within normal limits for pre-disturbance conditions, and within **applicable emergency limits** for the system conditions that exist following the **contingencies** specified in Section 3.1.

b. Line and equipment loadings shall be within normal limits for pre-disturbance conditions and within **applicable emergency limits** for the system load and generation conditions that exist following the **contingencies** specified in Section 3.1.

4. TRANSMISSION TRANSFER CAPABILITY

The interconnected New England **bulk power supply system** shall be designed with adequate inter-Area and intra-Area transmission transfer capability to minimize system reserve requirements, facilitate transfers, provide **emergency** backup of supply **resources**, permit economic interchange of power, and to assure that the conditions specified in Sections 3.1 and 3.2 can be sustained without adversely affecting the New England system or other Areas. Anticipated transfers of power from one **area** to another, as well as within areas, should be considered in the design of inter-Area and intra-Area transmission facilities. Therefore, design studies will assume applicable transfers and the most severe load and **resource** conditions that can be reasonably expected.

Firm transmission transfer capabilities shall be determined for Normal and **Emergency** transfer conditions as defined in Sections 4.1 and 4.2. Normal transfer conditions are to be assumed except during an **Emergency** as defined by Item 7 in Appendix A. In determining the **emergency** transfer capabilities, a less conservative margin is justified.

4.1 NORMAL TRANSFERS

For normal transfer conditions the New England **bulk power supply system** shall remain stable during and following the most severe of the conditions specified in Section 3.1 "a" through "h", with due regard for reclosing facilities, and before making any manual system adjustments.

Voltages, line loadings and equipment loadings shall be within normal limits for pre-disturbance conditions and within **applicable emergency limits** for the system load and **resource** conditions that exist following any disturbance specified in Section 3.1.

4.2 EMERGENCY TRANSFERS

For **emergency** transfer conditions the New England **bulk power supply system** shall remain stable during and following the most severe of the **contingencies** stated in "a" and "b" below. **Emergency** transfer levels may require adjustment of **resources** and, where available, phase angle regulator controls and HVDC controls, before manually reclosing faulted **elements**.

a. A permanent three-phase fault on any generator, transmission circuit, transformer, or bus section, with **normal fault clearing** and with due regard for reclosing facilities.

b. Loss of any **element** without a fault.

For **emergency** transfer conditions the pre-disturbance voltages, line, and equipment loadings shall be within **applicable emergency limits**. The post-disturbance voltages, line, and equipment

loadings shall be within **applicable emergency limits** immediately following the **contingencies** above.

5. EXTREME CONTINGENCY ASSESSMENT

Extreme contingency assessment recognizes that the interconnected bulk power system can be subjected to events which exceed in severity the **contingencies** listed in Section 3.1. Planning studies will be conducted to determine the effect of the following extreme **contingencies** on **bulk power supply system** performance as a measure of system strength. Plans or operating procedures will be developed, where appropriate, to reduce the probability of occurrence of such **contingencies**, or to mitigate the consequences that are indicated as a result of the simulation of such **contingencies**.

a. Loss of the entire capability of a generating station.

b. Loss of all lines emanating from a generating station, switching station or substation.

c. Loss of all transmission circuits on a common right-of-way.

d. Permanent three-phase fault on any generator, transmission circuit, transformer or bus section, with **delayed fault clearing** and **with due regard to reclosing**. This **delayed fault clearing** could be due to circuit breaker, relay system or signal channel malfunction.

e. The sudden dropping of a large load or major load center.

f. The effect of severe power swings arising from disturbances outside of New England

g. Failure of a Special Protection System to operate when required following the normal **contingencies** listed in Section 3.1 "a" through "f".

h. The operation or partial operation of a **Special Protection System** for an event or condition for which it was not intended to operate.

APPENDIX "A"

LIST OF DEFINITIONS

1. **APPLICABLE EMERGENCY LIMIT**
   These **emergency** limits depend on the duration of the occurrence, and are subject to NEPOOL standards.

   Emergency limits are those which can be utilized for the time required to take corrective action, but in no case less than five minutes.

   The limiting condition for voltages should recognize that voltages should not drop below that required for suitable system stability performance, and should not adversely affect the operation of the **bulk power supply system**.

   The limiting condition for equipment loadings should be such that cascading outages will not occur due to operation of protective devices upon the failure of facilities.

2. **AREA**
   An Area, (when capitalized) means one of: New Brunswick and Nova Scotia, New England, New York, Ontario or Quebec. An area (lower case) may mean a part of a system or more than a single system.

3. **BULK POWER SUPPLY SYSTEM**
   The bulk power supply system is comprised of generation and transmission facilities on which faults or disturbances can have a significant effect outside of the local **area**.

4. **CONTINGENCY** (as defined in NPCC Document A-7)
   An event, usually involving the loss of one or more **elements**, which affects the power system at least momentarily.

5. **DELAYED FAULT CLEARING** (as defined in NPCC Document A-7)
   Fault clearing consistent with correct operation of a breaker failure protection group and its associated breakers, or of a backup protection group with an intentional time delay.

6. **ELEMENT** (as defined in NPCC Document A-7)
   Any electric device with terminals which may be connected to other electric devices, usually limited to a generator, transformer, circuit, circuit breaker, or bus section.

7. **EMERGENCY**
   An emergency is considered to exist if firm load may have to be reduced because sufficient capacity or energy is unavailable after due allowance for purchases. Emergency transfers are applicable under such conditions. The emergency is considered to exist as long as any firm system load is potentially or actually curtailed.

8. **EQUIVALENT FORCED OUTAGE RATE**
   The equivalent forced outage rate (EFOR) is the ratio of total time a generator is completely forced out of service plus the equivalent full outage time of any forced partial restrictions, to the total time that the unit is not on scheduled maintenance.

9. **HVDC SYSTEM, BI-POLAR**
   An HVDC system with two poles of opposite polarity.

10. **NORMAL FAULT CLEARING** (as defined in NPCC Document A-7)
    Fault clearing consistent with correct operation of the protection system and with the correct operation of all circuit breakers or other automatic switching devices intended to operate in conjunction with that protection system.

11. **RESOURCE**
    Resource refers to any supply side or demand-side facility and/or action. Supply-side facilities include utility and non-utility generation and purchases from neighboring systems. Demand-side facilities include measures for reducing load, such as conservation, demand management, and interruptible load.

12. **SPECIAL PROTECTION SYSTEM (SPS)** (as defined in NPCC Document A-7)
    A Special Protection System (SPS) is defined as a protection system designed to detect abnormal system conditions, and take corrective action other than the isolation of faulted **elements**. Such action may include changes in load, generation, or system configuration to maintain system stability, acceptable voltages or power flows. Automatic under frequency load shedding as defined in NPCC Emergency Operation Criteria A-3, is not considered an SPS. Conventionally switched, locally controlled shunt devices are not SPSs.

13. **TEN-MINUTE RESERVE** (as defined in NPCC Document A-7)
    The sum of synchronized and non-synchronized reserve that is fully available in ten minutes.

14. **WITH DUE REGARD TO RECLOSING** (as defined in NPCC Document A-7)
This phrase means that before any manual system adjustments, recognition will be given to the type of reclosing; i.e., manual or automatic, and the kind of protection.

APPENDIX "B"

GENERAL GUIDELINES FOR DEMONSTRATING COMPLIANCE WITH SECTION 3 OF THE NEPOOL RELIABILITY STANDARDS

General guidelines for demonstrating compliance with criteria are outlined as follows:

- Testing should be performed to examine the performance of the system. This could be done using "standard" deterministic approaches, and must consider a sufficient range of reasonably stressed system conditions. A consensus of appropriate review groups would be required regarding the adequacy of the system test conditions.

- To demonstrate compliance with criteria:

  - Identify there are no operational restrictions, with all lines in service

    and

    all load can be served by available **resources** (allowing full use of **ten minute reserve**, phase shifters, HVDC control, etc.) with any facility assumed already forced out of service.

    or

  - If there are operational restrictions or conditions for which all load can not be served:
    1) Determine the predicted frequency, duration, period, and magnitude of the restrictions.
    2) Convert these findings into a statement describing their effects upon NEPOOL and its Participants.
    3) Establish the impact of these effects on the reliable and efficient operation of the bulk power system.

  Appropriate review groups will determine the acceptability of restrictions, based on the facts established.

This approach is based on the premise that compliance can be demonstrated if there are no conceivable problems or if it can be proven that potential problems are not significant. As stated, there must be agreement that a sufficient range of system conditions has been analyzed. The significance of any identified problems must be clearly and adequately described; the degree of

analysis required will depend on the problem. It may be possible to evaluate the significance of some apparently minor problems by simple means. Problems which appear to be of greater concern may require more substantial and rigorous analysis.